US 20180009158A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2018/0009158 A1**

Harkness et al. (43) **Pub. Date: Jan. 11, 2018**

(54) **FREE-FORM SPATIAL 3-D PRINTING USING PART LEVITATION**

(71) Applicant: **The Boeing Company**, Chicago, IL (US)

(72) Inventors: **William A. Harkness**, Mukilteo, WA (US); **Josh H. Goldschmid**, Woodinville, WA (US)

(73) Assignee: **The Boeing Company**

(21) Appl. No.: **15/693,684**

(22) Filed: **Sep. 1, 2017**

Related U.S. Application Data

(63) Continuation of application No. 14/446,141, filed on Jul. 29, 2014.

Publication Classification

(51) **Int. Cl.**

B29C 64/10 (2017.01)

B29L 9/00 (2006.01)

(52) **U.S. Cl.**

CPC ***B29C 64/10*** (2017.08); ***B29C 64/20*** (2017.08); *B33Y 10/00* (2014.12); *B33Y 30/00* (2014.12); *B29L 2009/00* (2013.01)

(57) **ABSTRACT**

A part is fabricated by an additive manufacturing process while levitating in space. Constituent features of the part are formed by 3-D printing. A part levitation system allows the spatial orientation of the part to be manipulated relative to one or more print heads.